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The progressive matrices (1938) with chronic brain disorder and chronic schizophrenic subjects

Ellis L. Schultz
University of Nebraska at Omaha

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THE PROGRESSIVE MATRICES (1938) WITH CHRONIC BRAIN DISORDER AND CHRONIC SCHIZOPHRENIC SUBJECTS

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D E Pedrini Psychology

Chairman Department

Graduate Committee George Holley Sociology

Name Department

Conrad H. Wurst Education

Francis M. Hurst Psychology

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Introduction

This is a report of a study which investigated the performance of two experimental groups of adult psychiatric patients and one group of noninstitutional control subjects on Sets A, B, C, D, and E of the 1956 revised edition of the Ravens Progressive Matrices (1938 Form, referred to throughout this paper as the PM). The two experimental subject groups consisted of a chronic schizophrenic reaction group and a chronic brain disorder without-psychosis group.

In this study the Wechsler Adult Intelligence Scale (WAIS) was primarily used as background with the PM used as foreground.

The PM is a test developed in England by J. C. Ravens as a measure of Spearman's g factor. As such, it requires primarily the eduction of relationships within abstract material. This test does not require verbal interactions, nor does it necessarily consist of verbal concepts. Rather, it consists of sixty matrices, or abstract designs, from each of which a part has been removed and the subject chooses the missing insert from six or eight alternatives. The items are grouped in five series, each containing twelve matrices of increasing difficulty, but similar in principle. The earlier series require chiefly accuracy in discrimination; the latter, more difficult series involve analogies, permutation and alteration of pattern, and other logical relationships. Reporting of scores was done in the form of percentile rating; norms were provided for each half-year interval between ages 8 and 14, and for each five year interval between ages 20 and 65 years. These percentile scores can then be transferred into one of five "grades," from intellectually superior to intellectually defective. For example, Grade I is "intellectually superior, at or above the 95th percentile" (Anastasi, 1954, pp. 261-262).

The PM is considered a promising instrument, especially in the evaluation of physically handicapped individuals (Tracht, 1948) and with a population requiring a "culture-free" test (Anastasi, 1961, p. 263).

Although the PM is often used as a measure of intelligence, Ravens (1956) is inconsistent in his views as to the use of this instrument by itself as a measure of intelligence. For example, he stated that the PM "indicates the rate at which a person may be expected to progress," that the PM "should be considered as a valid means of assessing a person's present capacity for clear thinking and accurate intellectual work," and that "a person's total score provides an index of his intellectual capacity, whatever his nationality or education" (Ravens, 1956). Thus he inferred that the PM is a measure of intellectual capacity but then went on to point out that "it is often useful to describe the scale as a test of observation and clear thinking. By itself it is not a test of general intelligence and it is always a mistake to describe it as such" (Ravens, 1956).

The author of this paper assumed that Ravens does not view the PM as an ipso facto measure of intelligence, but rather as an instrument which measures certain factors which correlate highly with intellectual capability. Ravens (1956) stated that the PM is used more to study the ability of the individual to "deal with abstract relationships clearly and accurately," and that the use of the instrument in the assessment of an individual's ability should always be used in conjunction with the Mill Hill Vocabulary Scale. This, of course, is not always possible. As an alleged "culture-free" test, the addition of a vocabulary instrument notably lessens the value of the PM. Also, in the use with deaf individuals, the vocabulary test may be impossible. If, then, the PM is to supplement the more specific types of individual tests (such as the WAIS or Stanford-Binet, in the United States), its area of primary value would be in populations which cannot be measured adequately by such instruments.

When dealing with subjects who are not influenced by organic or psychological deficits, Ravens (1956) stated that the PM showed a reliability of .83 to .93, depending primarily upon the age ranges involved in his sample (the nature of which is not clearly defined), with the highest reliability shown in the age group under thirty and the lowest reliability in the age group above fifty.

Julia Hall (1957) used a modified form of the PM with 82 nonpsychotic, nonbrain-damaged subjects. Hall administered the modified form of the PM, which consisted of half the total number of matrices on an odd-even selection procedure, with a liberal time limit. Her results showed a Kuder-Richardson reliability coefficient of .864. This included six subjects who did not complete the test in the time limit. If these subjects are excluded, the K-R coefficient is .878.

Using psychiatric subjects, Desai (1952) found a product-moment coefficient of correlation of 0.737 plus or minus 0.27 S.E. His study included 300 subjects tested at an interval of four weeks. The correlation coefficient attained with psychiatric patients would depend, in part, upon the specific disorder; in part, upon the time of test, etc.

Thus, although based on a relatively small number of research studies, it may be hypothesized that the PM is a relatively reliable measure.

The validity studies with the PM have mostly dealt with the PM in relation to instruments aimed primarily at the measurement of intelligence, which is not exactly what Ravens (1956) considered his test to be. Thus, these studies may be somewhat inaccurate at best.

Ravens (1956) pointed out a correlation of 0.44 to 0.60 when studied in conjunction with the Mill Hill Vocabulary Scale, depending upon the age range of the subjects. Again, as with reliability, the correlations were higher in the age group under thirty and lowest in the age range above fifty.

Burt, as reported by Ravens (1956) with the test results of 1,000 seamen, reported a correlation of 0.86 with the Terman-Merril revision of the Stanford-Binet.

Julia Hall, in the study reported previously using the modified form of the PM, found the following correlations with the Wechsler Adult Intelligence Scale: Modified PM and WAIS, Full Scale score 0.72; PM and Verbal Scale score 0.584; and PM and Performance Scale score 0.705.

Levine and Iscoe (1954) studied the PM in relation to the Chicago Non-verbal and the Wechsler Bellevue with deaf adolescents. The scores of the deaf school resident students on the 1938 form of the PM compared with their Chicago Non-verbal (N=36) and W-B, Form 1, Performance Scale (N=41) scores. The "r" Pearson Product Moment Coefficient of Correlation with the Chicago was .41, with the W-B performance scale .55--the latter being significant at the .01 level.

Barret (1956) studied the relationship of the 1938 PM and the Columbia Mental Maturity Scale with the Wechsler Intelligence Scale for Children. Barret found the following correlations with the PM for the WISC Verbal Scale of .692, and for the WISC Performance Scale of .699. Both of these relationships were significant at the .01 level of significance. The only subtest of the WISC which did not correlate at the .01 level of significance was the Comprehension Subtest.

Bolin (1955) attempted to study the range of applicability of the PM and the degree of equilavence with standard scales of general intelligence. He stated,

Comparison of PM with tests consisting of sections of homogeneous, well understood items can contribute to understanding of the first question; examination of correlations between PM and various 'General Intelligence' scales can help to solve the second problem. The widely used American Council on Education Psychological Examination for College Freshmen (ACE) is made up of sections of seemingly homogeneous items sampling rather specific functions. The Otis Gamma Mental Ability Test is popular as a group test of general intelligence.

Bolin administered on separate occasions and under similar group conditions the ACE, the Otis Gamma Form D, and the PM. The following correlations are reported: PM and ACE total score, 0.48; the PM and ACE linguistic score, 0.29; the PM with ACE total score, 0.59; and the PM with the Otis Gamma, 0.65. Bolin suggested that the low PM-ACE linguistic correlation confirmed the opinion that the PM best measures nonlinguistic areas of intelligence, and that the PM's high correlation with ACE quantitative tests (which involve arithmetical reasoning, number series, and figure analogies) would suggest that the PM may be especially vulnerable to pathology since such abilities are conceded to be so. He thus suggested that the PM should not be utilized in assessing "original endowment" in clinical cases but possibly useful in estimating loss.

Although several of the mentioned studies have dealt with psychiatric subjects, their aim was not specifically to study the effect of a psychiatric or organic dysfunctioning on the individual PM record, nor to determine between or within group differences.

In considering the PM in terms of psychiatrically disturbed or brain damaged persons, Ravens (1956) felt it was quite important to note that the PM by itself was not a measure of intellect. He thus advised using the test in conjunction with the Mill Hill Vocabulary Scale, which has a much higher retest reliability (Ravens, 1956). When used in conjunction with this scale, Ravens suggested that a difference of two grades (based on percentile ranges) between the two instruments should always be checked out. For example, if the PM was significantly higher than the Mill Hill Vocabulary Scale, one would suspect that the subject had not received, or for some reason had not been able to acquire, the general information and command of the English language his intellectual capacity warranted. On the other hand, it can be assumed that a PM score lower than the Mill Hill Vocabulary Scale score occurred when a person was suffering from fatigue, temporary intellectual impairment, had deteriorated mentally, or had for some reason excessively directed his available mental activity to the acquisition of verbal knowledge.

Ravens (1956) also suggested another method of measuring the consistency of a PM test record. He utilized the "discrepancy score," which is arrived at as follows:

By subtracting from a person's score on each of the five sets the score normally expected on each set for the same total score on the scale, the consistency of his work can be assessed. (The score to be expected is given in Tables One and Two of the Manual.) The difference between the score a person obtains on each set and that normally expected can be shown numerically as follows: Discrepancies 0, -1, +2, -2 and +1. If a person's score on one of the sets deviates by more than two, his total score on the scale cannot be accepted at face value as a consistent estimate of his general capacity for intellectual activity. For general purposes the total score appears to be relatively valid even when discrepancies of more than two points occur in the breakup.

Therefore, Ravens considered two methods of controlling the interpretation of the PM in light of possible interference from organic or emotional factors. The first was that of using the PM in conjunction with the Mill Hill Vocabulary Scale, the second was to study the PM record in terms of its internal consistency as measured by the discrepancy scores.

Research literature suggests inadequacies in both methods. For example, the PM is often used in situations where for one reason or another the Mill Hill Vocabulary Scale is not applicable. A good example is the use with deaf individuals, another is the widespread and increasing use of the PM with non-English speaking populations. It is possible in the latter case to use a vocabulary scale in the language of the subject, but as Ravens points out, the relationships may not be the same.

Both the discrepancy scores and relation of PM percentile scores to vocabulary have been studied by Kasper (1958), whose paper summarized PM and WAIS vocabulary test relationships to morbidity scores derived from the Lorr Multi-dimensional Rating Scale for Psychiatric Patients (MSRPP); and the relationship to morbidity of two points or more deviation between expected and actual scores in any of the PM's five sets of twelve items each (the discrepancy score). Kasper used fifty subjects without organic pathology. All were first admissions to a state hospital and were taken consecutively. Subjects were grouped on prorated WAIS V scores so that they would fall within: (a) below 90 IQ, (b) 90 - 110 IQ, or (c) above 110 IQ. PM percentile scores were converted and grouped similarly. PM and WAIS V were in 48% agreement. No relationship was found between ratings of morbidity and estimates of intellectual functioning, and differences in mean morbidity scores for the various discrepancies between intelligence measures do not clearly demonstrate a concomitant variation between events. Kasper stated, "The results, then, consistently fail to demonstrate PM's efficiency in discriminating the influence of pathology and that none of the disparities among PM sets of score is meaningfully related to morbidity score." He concluded, "The results, in general, point to considerable ambiguity and lack of validity in interpretations of PM scores with heterogeneous clinical populations" (Kasper, 1958).

With organic patients, four noteworthy studies are apparent. The first three of these, done with the 1947 coloured matrices, may not be applicable to a specific study of this form (the PM of 1938), but are of general interest. Costello (1959) noted that the PM (coloured 1947 form) is used a great deal with cerebral palsied children, and that visual form perception is often poor in brain injured children, ran a study dealing with wrong answers of aphasic cerebral palsied children as compared with post-polio children with no organic involvement. Costello (1958) found a consistent difference in frequency with which the particular type of wrong answer on the PM is chosen by a group of aphasic cerebral palsy children and a control group of post-polio children. It must be noted that Costello based his results on a quite small sample, utilizing only ten subjects in each group. Thus, the results may not project to a larger group, but are definitely noteworthy in the study of the PM.

Dils (1960) also utilized the coloured PM in studying a group of sixty subjects with positive medical evidence of irreversible brain damage, a group of sixty subjects without evidence of such, and a group of eighteen subjects referred to as questionable in terms of brain damage. He used a form of scatter analysis to differentiate the protocols of organics from those of controls. Since this paper did not utilize the item analysis approach, a description of Dils' scatter analysis is not given. Suffice it to say that Dils correctly identified 82% of the organics and 92% of the controls, significant at the .001 level of significance (Median test). Exactly 50% of the questionable group were above or below the cutoff point. Dils concluded that the coloured PM may be a valuable instrument for the detection of organic brain dysfunction when conditions of psychosis and idiopathic mental deficiency can be excluded.

Urmer, Ann Morris, and Wendland (1960) studied the 1938 form of the PM with adult brain damaged individuals, using twenty subjects--eighteen of whom were left hemiplegics and two of whom were right hemiplegics. These subjects were matched on the basis of age and sex with a group having a medical diagnosis of a non-neurological nature. The authors randomly administered the PM and the WAIS (with the exception of the Digit Symbol subtest which was omitted). Their results indicated significant intellectual performance differences between the two groups. Using those subtests least sensitive to brain damage--the Information, Comprehension, and Vocabulary--they compared the two groups and found both groups similar as to intellectual function when the effect of organic involvement was minimized. The organic group showed significantly lower scores on the PM, significantly lower scores on all five subtests, and much more inconsistency in terms of a consistency score based on the assumption that the items within any set were ordered as a function of difficulty and fewer errors should therefore be made on the earlier items in each set. It might be pointed out that the differences in consistency scores for the two groups did not differ on Set E, the most difficult group as a function of their deviation score (discrepancy score) based on Ravens' normal score composition. Finally, the authors found that the brain damaged group showed a consistent type of errors on the PM; i.e., whenever possible the brain damaged group made an error by figure-ground reversal.

Evans and Marmostan (1964) used four methods of studying impairment as a result of organic cerebral dysfunction. The first used was the total raw score. The second was the "consistency score" used by Urmer, Ann Morris, and Wendland (1960) reported above. The third was Dils' (1960) "scatter analysis," and the fourth was an item analysis also reported by Dils (1960). Evans and Marmostan concluded that coloured PM responses of 71 brain damaged and 60 control subjects could be successfully differentiated on the basis of the four scoring methods, and that the four methods were significantly related to diagnosis (cerebral thrombosis versus myocardial infarction) and were positively related to each of the other scoring methods.

Problem

This study was constructed to observe the effect of two types of clinical pathology and their relationship to the PM.

The literature presented suggests that the PM has shown adequate reliability and validity with normal subjects. The results have been less convincing with psychiatric subjects and also suggest that the PM is not a good instrument for assessing basic intellectual abilities. These results confirm Ravens' statement that the PM is not by itself intended to be a measure of basic intellectual ability.

The studies do not confirm Ravens' speculation that his "discrepancy scores" will identify emotional or organic factors which interfere with the validity of the interpretation of the individual PM record. Three studies have suggested that the brain damaged subject will react to the coloured PM with figure-ground reversals, or other predictable types of response errors. One study with the PM suggested the same results.

Thus, the previous research suggests two conclusions: First, that the PM is a useful index in studying intellectual performance; and secondly, that the PM should be interpreted with caution, especially in terms of basic intellectual ability.

No studies have attempted to determine the PM's relationship between psychotic disorders and brain damage, or between psychotic disorders and normal control subjects. This paper is an attempt to do so; namely, to study the relationships of a chronic brain disorder group without-psychosis, a chronic schizophrenic disorder group, and a noninstitutional group in terms of performance on the PM and the WAIS. The WAIS was primarily used as background and the PM was used as foreground. In other words, the persons in the three groups were matched across rows on alleged premorbid functioning (WAIS Information, Comprehension, and Vocabulary), age, and sex, and contrasted with regard to the rest of the WAIS subtests and the PM.

This study attempted to determine the performance of three groups of subjects on the PM and portions of the WAIS (the Arithmetic, Similarities, and Digit Span subtests of the Verbal Scale; and the WAIS Performance subtests as described by Wechsler, 1958). The WAIS Information, Comprehension and Vocabulary subtests were used as a part of the matching criteria and were thus part of the background material. The WAIS Verbal and Full Scale scores were thus contaminated and could not be studied as foreground material.

The three groups were: Psychiatric patients with a diagnosis of chronic brain disorder without-psychosis, psychiatric patients with a diagnosis of a chronic schizophrenic reaction, and noninstitutional subjects.

It was generally hypothesized that subjects drawn from each of the three groups and matched individually in terms of age, sex and a measure of premorbid intellectual ability would perform the PM in a statistically predictable and statistically significant relationship in terms of total PM raw scores, in terms of PM discrepancy scores, in terms of individual PM set raw scores, and in terms of relationships with WAIS Arithmetic, Similarities and Digit Span scores, and WAIS Performance Scale scores.

More specifically, these hypotheses are stated as follows: (1) There will be no statistically significant difference between total PM scores of matched subjects drawn from the chronic brain disorder without-psychosis, the chronic schizophrenic, and the noninstitutional samples. (2) There will be statistically significant differences between the chronic brain disorder without-psychosis group, the chronic schizophrenic group, and the noninstitutional group in terms of discrepancy scores.

(3) No statistically significant differences will be obtained between the chronic brain disorder without-psychosis group, the chronic schizophrenic group, and the noninstitutional group in terms of raw score differences on individual Sets A, B, C, D, and E of the PM. (4) There will be no statistically significant differences between the coefficient of correlation of the chronic brain disorder without-psychosis group, the chronic schizophrenic group and the noninstitutional group relative to their performances on the PM as compared with the WAIS Performance Scale sum of scaled scores and with the sum of the WAIS Arithmetic, Similarities, and Digit Span scaled scores.

Method

Subjects

The subjects for this study were drawn from three samples. The first sample was that of psychiatric inpatients with the diagnosis of a chronic brain syndrome without-psychosis, the second sample was that of psychiatric inpatients with the diagnosis of a chronic schizophrenic reaction, and the third sample was that of a noninstitutional group made up primarily of hospital employees.

All subjects were within the age range of 20 - 55 years and were considered to be of basically average to above average premorbid intellectual level (as suggested by the projected premorbid IQ described in the design of Procedures Section of this paper). There were twelve men and eight women in each sample. A breakdown of the age, sex, and projected premorbid IQ (Pre IQ) can be seen in Table 1.

The chronic brain disorder subjects were chosen on the basis of a consistent impression by the diagnostic medical staff of the St. Joseph State Hospital, including a trained neurologist and a trained psychiatrist. Although psychological studies were available for most of these subjects, the presence of organic signs on such instruments was not made a criteria for selection in this sample in order to prevent restricting the sample to only those subjects who could be expected to show some deterioration on other types of psychological testing.

By the same merit, this study was not intended to deal with any specific type of brain pathology, and subjects were used who showed a wide range of pathology within the scope of the chronic brain disorder without-psychosis. Four subjects were used who had received brain damage due to head injuries, and two were used who had incurred tumors. For these six subjects, a localized brain damage was suspected. In the remainder of the subjects (n=14), the chronic brain syndrome was felt to be generalized.

It was neurologically predicted that the brain damage was irreversible; i.e., chronic, that no predictable remission of symptoms was likely.

The chronic schizophrenic subjects were taken from the inpatient population of the St. Joseph State Hospital. The primary criterion for their selection was the diagnosis of a schizophrenic reaction of chronic duration by the diagnostic medical staff of that hospital. Such staffings are conducted by one of two trained psychiatrists. All of the subjects in this group had been first diagnosed as a schizophrenic reaction at least three years prior to their involvement in this study, and most of them much more than this minimal time period. Several of these subjects (n=8) had been on short leaves from the hospital since the time of their first schizophrenic diagnosis, but none had been discharged. It must be recognized that most, if not all, of these subjects were in some form of psychiatric treatment (such as chemo-therapy), and that this may have had an unknown effect on their total test performance. No subjects in this sample were known to have any history of brain pathology.

The noninstitutional sample consisted primarily of St. Joseph State Hospital employees, although four subjects were secured from a local division of the State Merit System. All subjects were naive as to training in the administration, scoring, or interpreting of any forms of psychological tests. The bulk of subjects from within the hospital employee sample were hospital aides or attendants (n=14). All subjects in this sample denied ever having received any severe head injury or having been unconscious for any great length of time. All subjects within this sample also stated they had never received treatment for any emotional disorder.

Procedure

Three groups of subjects, one group made up of psychiatric patients with a diagnosis of chronic brain disorder without-psychosis, one made up of hospitalized psychiatric patients with a diagnosis of a chronic schizophrenic reaction, and one group made up of noninstitutional subjects, were administered the WAIS and the PM. Twenty subjects were included in each group. Subjects were matched individually across columns on the basis of age, sex, and premorbid intellectual level. The matching criteria are as follows:

(a) Age. Subjects were matched within a range of five years from a total age range of 20 - 55 years. A five year age span was chosen for matching due to Ravens' percentile ranking of raw scores on the PM. He gives a percentile rating for raw scores on a five year interval based on a total age range beginning at age 20 and progressing in five year intervals up to age 65. Thus, subjects were matched in one of seven intervals: Age 20 through 24, age 25 through 29, age 30 through 34, age 35 through 39, age 40 through 44, age 45 through 49, and age 50 through 54 (Ravens, 1956).

(b) Sex. Members of each group were matched with persons of like sex.

(c) Premorbid IQ. Premorbid IQ was suggested by administering the Information, Comprehension, and Vocabulary subtests of the WAIS, then summating the scaled scores of the three. These scaled scores were then prorated into a verbal IQ, which became the premorbid IQ (Pre IQ). These three subtests of the WAIS are felt to be the least affected by either organic or emotional interference (Morrow and Marx, 1955). Subjects were matched in such a manner that all were within one standard error of each other, assuming standard error equals 15 (Wechsler, 1958).

Thus, the study compared twenty triads (Table 1) of subjects, each subject in a particular triad being of the same general age, Pre IQ, and sex. The only difference was that one each was drawn from the noninstitutional, chronic brain disorder without-psychosis, and chronic schizophrenic reaction groups. It was assumed that any differences between the column totals (Table 1) relative to their performances on the PM, the remainder of the WAIS subtests, or the relationships between the two test performances, would be a function of their psychiatric disorder rather than a function of basic differences due to age, sex, or differing levels of WAIS premorbid intellectual capacity.

In the study, the chronic brain disorder patient without-psychosis was administered the criteria to determine premorbid intellectual level. If he was functioning on or above the point of minus one standard error (roughly IQ 85 or above) in terms of the projected premorbid IQ, the testing was continued with the remainder of the WAIS and the PM administered. Subjects from the other two groups were then matched as to age, sex, and premorbid IQ. If they fit within the criteria specified, they too were administered the remainder of the WAIS and the PM in the same order as the chronic brain disorder subject. The order of presentation was varied in an ab-ba order, so that ten of the subject triads performed the remainder of the WAIS first, and ten of the subject triads performed the PM first.

Subjects were administered the remainder of the WAIS (Wechsler, 1958) with all subtests other than those used as matching criteria given in prescribed sequence. The PM was administered in terms of the instructions to the subject for the "Self-Administered or Group Test," although the subjects were not tested in groups (Ravens, 1956). The record forms on the PM were checked to note any mistakes or omissions, and subjects were told to correct such mistakes and complete all items. If, however, certain subjects refused to do all items on the PM, they were not required to do so. One each of the noninstitutional and chronic schizophrenic groups failed to do so--noninstitutional Code No. 80 and chronic schizophrenic Code No. 48. These two subjects were not excluded from the study.

The responses to the WAIS and the PM were recorded on the standard record forms used for these instruments.

The PM records were tabulated in terms of raw scores; i.e., number of items correctly completed for the PM total and each PM set. The PM set and total raw scores were subjected to analysis of variance techniques. Although the total raw score was then transferred to a percentile rating as indicated by Ravens (1956), these resulting percentiles were not subjected to any form of statistical test.

The PM discrepancy scores described by Ravens (1956) were tabulated and subjected to statistical analysis. A decision was made for each subject as to whether his PM set scores exceeded a +2 or -2 deviation from the normal or expected set score for his raw score total. If it did, the subject was considered to have shown a significant discrepancy. Thus, a yes - no categorization for each subject was formulated and the resulting totals for each clinical group were subjected to Chi Square techniques.

The WAIS raw scores were transferred to scaled scores as described by Wechsler (1958). These scaled scores were not corrected for age with the exception of the premorbid IQ (Information, Comprehension, and Vocabulary) totals (described earlier), which were used for matching purposes. All WAIS scores subjected to statistical analysis were in the form of scaled scores or sums of scaled scores. With an equal interval scale and a known mean and standard error for each subtest (Wechsler, 1958), parametric statistical methods could thus be used (Siegel, 1956, p. 31). WAIS scores subjected to analysis of variance techniques were the Arithmetic, Similarities, and Digit Span subtests and Performance subtests as foreground data, the Information, Comprehension, and Vocabulary (Pre IQ) as background data, and the total of all six verbal subtests (which was compounded by use of both background and foreground data). Product moment coefficients of correlation (r) were computed for age, sex, and PM with both WAIS contaminated (used as both background and foreground) and uncontaminated (used only as foreground) sets of scores. Thus, two tables of r were found for each diagnostic sample. The uncontaminated table was composed of age, sex, sum of WAIS Arithmetic, Similarities, and Digit Span subtest scaled scores, WAIS Performance sum of scaled scores, and PM. The second table was composed of age, sex, sum of WAIS Pre IQ (Information, Comprehension and Vocabulary) subtest scaled scores, WAIS Verbal Scale sum of scaled scores, WAIS Full Scale sum of scaled scores, and PM raw score total.

The rationale and methods for computing these particular coefficients will be discussed in the section relative to the presentation of these findings.

The above were the types of scores subjected to statistical analyses in this paper, and general explanation of the types of statistical tests used.

Specific discussion of the particular data combinations subjected to statistical analyses and specific explanation of the statistical techniques used will be described in the following section.

Initial tests for homogeneity of variance were used to determine the applicability of analysis of variance techniques without using scale transformations. Column totals were studied by one of two methods for each test combination subjected to analysis of variance techniques. These methods were the Hartley Fmax statistic and the Cochran C test, both described by Winer (1962, pp. 93-95).

For all but the PM scores, the Hartley Fmax test showed the hypothesis of homogeneity of variance tenable. The PM results with Hartley Fmax statistic were questionable, and since the Fmax statistic table presented by Winer only extends to ten columns, the Cochran C test was administered. The results showed C = .148, between the critical value at the .01 point and the .05 point. Thus, only minor deviations from homogeneity of variance were suspected.

Since the F test in the analysis of variance is robust with respect to departures from homogeneity of variance (Winer, 1962, p. 239), analysis of variance methods were used without scale transformations.

A total of five basic combination of scores were studied by the analysis of variance. Each of these was subjected to three different analysis of variance models in an effort to ascertain the effect of known variables which could lead to significant results related to the major hypotheses being tested.

The WAIS and PM were studied in a consistent series of three factor analysis of variance techniques (Winer, 1962, pp. 140-224). The first combination was that of the Pre IQ matching criteria, which was part of the background data. The second was the PM raw scores. The third combination was the WAIS Arithmetic, Similarities and

Digit Span subtests. The fourth combination was the total WAIS Verbal Scale, which combined the Pre IQ subtests and the Arithmetic, Similarities, and Digit Span subtests. The final combination was the WAIS Performance subtests.

The Pre IQ and WAIS Verbal Scale were studied as incidental data. Since the Pre IQ was used as background, such scores could not become part of the statistical results. Neither could the WAIS Verbal Scale, since it is made up in part of the Pre IQ subtests. This tended to contaminate the results associated with WAIS Verbal Scale.

Each of the five combinations of scores was studied in a 20 x 3 x C model to note the relationships between the subject triad factor, the diagnostic factor and the particular subtest or set factor involved. In this model the cell frequency equaled 1 and experimental error was assumed 0. The ABC interaction Mean Square (M.S.) was used in its place as an error term with all factors fixed (Winer, 1962, p. 216). This meant, then, that a measure of the significance of the triple interaction and an error estimate were lacking. To provide such, as well as to estimate the effect of age and sex factors, two 2 x 3 x C models were assumed with: A = sex, B = diagnosis, and C = the subtest or set; and with A = age, B = diagnosis, and C = subtest or set. Since the age ranges could not be divided into equal interval categories, each diagnostic group was divided into the ten youngest (A_1) and ten oldest (A_2) subjects and the three factor analysis of variance as described by Winer (1962, pp. 140-224) was applied. The 2 x 3 x C with A = sex was done using an unweighted means analysis of variance (Winer, 1962, pp. 222-224) to correct for unequal cell frequencies since there were 12 men (A_1) and 8 women (A_2) in each diagnostic group. Five sources of possible variance were considered within each combination of scores. They were: (1) Subject triads; (2) Age; (3) Sex; (4) Diagnosis; and (5) Subtest or set.

These analyses of variance were then followed by the appropriate a posteriori tests suggested by Winer (1962, pp. 77-89) when significant effects were noted. These will be described in the section relative to each of the five combinations.

The Chi Square technique was used only in conjunction with the discrepancy scores on the PM. The particular technique used was the Chi Square for k independent samples as described by Siegel (1956, pp. 175-179). Then the three groups were compared individually with each other. Again, results are reported in the appropriate section of this paper.

Results

Pre IQ

The Pre IQ, used as background, was studied statistically to test the assumption of matched subjects on the variable of Pre IQ.

Three analysis of variance models (Winer, 1962, pp. 140-224) were used: (1) a 20 x 3 x 3 model with A = subject triads, B = diagnosis, and C = subtest; (2) a 2 x 3 x 3 analysis of variance model with A = age, B = diagnosis, and C = subtests; and (3) a 2 x 3 x 3 unweighted means analysis of variance model (Winer, 1962, pp. 222-224) with A = sex, B = diagnosis and C = subtests. Five sources of variance were thus studied by these models. They were subject triads, age, sex, diagnosis, and subtests.

The main effects of the subject triads were significant at the .01 point (Table 2). Such a finding in itself is of limited value, since no attempt was made to equate the subject triads between rows (Table 1).

The main effects of age were significant at the .01 point, with older subjects scoring higher than younger (Table 3).

The main effects of sex were significant at the .01 point with men scoring higher than women (Table 4).

The main effects of subtests were significant at the .05 point in the 20 x 3 x 3 analysis of variance model, (Table 2), but not significant in the other two analysis of variance models (Tables 3 and 4). Although the column totals for subtests were the same for the three analysis of variance models, the divisors for the F ratios were different. The significance of the F ratio in the 20 x 3 x 3 analysis of variance model appeared due to the use of the mean square of the triple interaction as an error term, since with n = 1 for each cell, no estimate of experimental error was available (Winer, 1962, p. 239).

In summary, when each subject triad was compared with each other subject triad, the main effects of the subject variable were significant at the .01 point and all interactions with the subject variable were also significant. When age or sex were considered, however, only the main effects of each were significant. Thus, the two additional analyses of variance tended to explain the significance of the interactions between subject triads and diagnosis and between subject triads and Pre IQ subtests.

These two analyses of variance pointed out that in terms of Pre IQ, older subjects scored higher than did younger within each diagnostic group, and men scored higher than women in each diagnostic group. These findings in themselves were of little value, since no attempt had been made to match Pre IQ in terms of sex or age levels. Subjects had been matched across columns only, for the three variables of Pre IQ, sex, and age. Looking at Table 1 should further clarify this. Comparisons between these patterns on the Pre IQ and patterns on other of the test combinations were interesting, however, and will be explained in the appropriate section of the paper.

Progressive Matrices

As were all test combinations, the PM set scores were evaluated in terms of 3 three-factor analyses of variance: The first a 20 x 3 x 5 analysis of variance model with A = subject triads, B = diagnosis, and C = PM sets; the second a 2 x 3 x 5 analysis of variance model with A = age, B = diagnosis and C = PM sets; and the third an unweighted means 2 x 3 x 5 analysis of variance model with A = sex, B = diagnosis, and C = PM sets.

The analyses of variance are summarized in Tables 5, 6, and 7. As will be noted, the patterns of the three analyses of variance are quite similar. It was seen that Factor B, diagnosis, showed a consistent significant main effect at the .01 point in each of the three analyses of variance. Factor C, PM sets, also assumed the same results. These, of course, were expected since the totals were the same for all three analyses. Factor A, being different for the three models even though it dealt with subject factors, did not show a consistent pattern and could not be assumed to do so. With the A factor measuring three potential sources of variation, five sources were actually subjected to analysis. These were: (1) Subject triads, (2) Age, (3) Sex, (4) Diagnosis, and (5) PM set scores.

The interaction effects of the three analyses of variance were all consistent, with BC, AC and ABC being not significant and the AB interaction being significant. Again, with the A factor being different for each, specific interpretation will be given for each.

Subject Triads. The main effects for subject triads were significant at the .01 point (Table 5). As such, a significant main effect can be interpreted that the twenty triads of matched subjects scored differently on the PM. Such an interpretation is, of course, not meaningful since no attempt was made to equate the subject triads in terms of age, sex, and Pre IQ.

Age. The main effects of age were significant at the .01 point (Table 6). Inspecting the totals used in arriving at this, it was noted that the younger subjects scored higher than did the older subjects. With the AB interaction for this model significant at the .01 point, further discussion of the meaning of this will be given in the interpretation of the age - diagnosis interaction.

Sex. Here, an attempt was made to control subject variability. For example, in the 2 x 3 x 5 unweighted means analysis of variance with A = sex, the main effects of sex were not significant. Thus, it could be assumed that with the overall totals, no significant PM score difference due to sex differences were noted. Since the AB interaction of this model was significant, however, a further discussion of the validity of such an assumption is withheld at this point.

The diagnostic factor showed significance at the .01 point in all three models. Since the diagnostic totals were the same for all three models, only one interpretation needs to be made--the three diagnostic categories scored differently on the PM. To make this more specific, the Tukey (a) procedure as described by Winer (1962, pp. 85-89) was applied. Results are presented in Table 8. As shown, it was found that the NI group scored significantly higher (.01) than did both the CS and BD groups. No significant differences were noted between the CS and BD groups.

The main effects for PM sets were found to be significant at the .01 point. This, of course, is an artifact, since the very nature of the PM would tend toward such results. The normal score distribution is for each set score to be progressively lower than the preceding set score (Ravens, 1956). For example, subjects are expected to score higher on Sets A and B than on Sets C, D, and E, although some overlap is possible. In effect, there are differences between total scores on the PM sets. Applying an a posteriori test to such findings seemed unnecessary, since the meaning of such differences would be nil.

Interpretation of interaction. In the 20 x 3 x 5 model, the subject - diagnosis interaction was significant at the .01 point. This, however, was not too meaningful, since no attempt had been made to equate subject triads in terms of age, sex, and Pre IQ. Subjects were matched in triads across columns, and the triads were not balanced between rows. Table 1 helps to clarify this. Thus, a posteriori tests were not administered.

The AB interaction in the 2 x 3 x 5 unweighted means model was significant at the .01 point. This can be interpreted that sex differences did not consistently show the same variations for each diagnostic group. Two possible explanations could account for significant interaction. One is that there actually are inverse relationships between corresponding levels of cell means, and the other is that the rank order is the same but due to large variations within the same level of one factor on different levels of the other factor, a significant departure from linearity results (Lindquist, 1956, pp. 228-230).

One method of studying the significant interaction effects is to break the cell means down into their respective variance components (Lindquist, 1956, p. 372). While this does not offer much in the way of interpretive significance, it does offer at least some way of quantifying the differences. These were computed only for the interaction effects since the main effects were studied by other procedures. In order to achieve orthogonal relationships, the cell totals were weighted, since the cell frequencies of men and women were different.

The orthogonal variance components for sex - diagnosis on the PM are presented in Table 9. As noted, the major differences appeared to be in the inverse relationship of the BD group compared with the NI and CS groups. Although the overall main effect of sex was not significant, it was noted that the BD group scored in an opposite direction from the NI and CS groups in terms of sex - diagnostic levels, and that the differences were quite pronounced. How much interpretive significance these results indicate is questionable, since the cell frequencies were relatively small and the BD group encompassed a wide range of disorders within this general category. It is quite possible that this finding reflects only a great deal more random variability within the brain damage group than in the other two groups.

The interaction between age and diagnosis was found significant at the .01 point. As with the sex - diagnosis condition, variance components were computed for the age - diagnosis cell means. The variance components of age - diagnosis interaction are presented in Table 10.

In this case, means of cell totals were used since the cell frequencies were equal. It was found that the older NI subjects scored higher on the PM than did younger NI subjects. In the BD and CS groups, the opposite was true. However, the significant interaction appeared to relate more to the extremely low showing of the older BD subjects as compared with older subjects of the other two groups. In effect, although the NI and CS groups showed differing patterns, the extent of the difference was much less than that due to the extremely poor performance of the older BD group.

Chi Square

The Chi Square technique was used to study hypothesis (2), that of no significant differences between the three diagnostic groups in terms of the discrepancy scores described by Ravens (1956). The Chi Square technique for k independent samples as described by Siegel (1956, pp. 175-179) was used to study overall differences of the three diagnostic groups.

The NI group showed four subjects with significant discrepancies, the CS group showed seven subjects with significant discrepancies, and the BD group had twelve subjects with significant discrepancies. The obtained Chi Square of 6.88 was statistically significant at the .02 level (Siegel, 1956, p. 249).

The discrepancy totals between pairs of groups were compared using the Chi Square technique for two independent samples as described by Siegel (1956, pp. 104-111). The only significant Chi Square obtained was between the NI and BD groups. Chi Square for this comparison was 2.84, significant at the .01 level.

WAIS Verbal Subtests

The WAIS Verbal subtests were actually broken into three separate combinations of scores--the Pre IQ, the Arithmetic, Similarities and Digit Span, and the total of all six taken together.

The Pre IQ studies as background data have already been dealt with to some extent, since they were used as part of the matching criteria. In this section, the results found in the Arithmetic, Similarities and Digit Span analyses of variance are first presented, then the complete verbal results are presented.

As in all of the test score combinations studied by analysis of variance techniques, the Arithmetic, Similarities, and Digit Span, and WAIS Verbal were subjected to three different analyses of variance, with a resulting total of five variables being subjected to analysis. These were: (1) Subject triads; (2) Age; (3) Sex; (4) Diagnosis; and (5) Subtests.

The variables and the findings associated with them are:

Main effects of subject triads were significant at .01 point, again comparable to the Pre IQ. With no attempt made at controlling random subject variability, significant differences do not seem very meaningful. These results are shown in Table 11.

Main effects of age were significant at the .05 point. Older subjects scored higher than younger, paralleling the findings of the Pre IQ (Table 12).

Main effects of sex were not significant.

Main effects of diagnosis were significant at the .01 point (Tables 11, 12, and 13). The Tukey (a) procedure as described by Winer (1962, pp. 85-89) was used to clarify the meaning of the significant main effect due to diagnosis. It was found that the NI group did significantly better than both clinical groups (.01 point) and that the CS group did significantly better (.01 point) on the sum of these subtests than did the BD group. These results are shown in Table 14.

WAIS Verbal Scale

The WAIS Verbal Scale subtests have already been considered in terms of two separate subtest combinations--the Pre IQ and the Arithmetic, Similarities and Digit Span. In an effort to study the WAIS Verbal Scale as an entity as recommended by Wechsler (1958, p. 112), a separate statistical analysis was completed.

Since the Information, Comprehension, and Vocabulary subtests were used as a matching criteria, however, the sum of all WAIS Verbal subtests was contaminated. Only certain sums of Information, Comprehension and Vocabulary were found acceptable as matching criteria and this may have contaminated WAIS Verbal Scale totals.

Again, three separate analyses of variance were used with a total of five variables being considered: The first a 20 x 3 x 6 model with A = subject triads, B = diagnosis, and C = subtests; second a 2 x 3 x 6 model with A = age, B = diagnosis, and C = subtests; and the third an unweighted means 2 x 3 x 6 model with A = sex, B = diagnosis, and C = subtests.

The main effects for subject triads were significant at the .01 point. This in itself is not too meaningful since no attempt was made in this model to equate the subject triads in terms of age, sex and Pre IQ. These results are shown in Table 15.

The main effects for age were significant at the .01 point. This was not surprising, since in both the Pre IQ and Arithmetic, Similarities, and Digit Span combinations the same finding held. The older subjects scored higher than did the younger, which probably relates to the matching procedures rather than to any overall population trends (Table 16).

The main effects of sex were significant at the .05 point. As reported previously, main effects for sex with the Pre IQ were significant at the .01 point, and not significant with the Arithmetic, Similarities, and Digit Span. Thus, the marginal .05 significance of all Verbal subtests prehaps reflects the effect of combining both into a single scale (Table 17).

The main effects for diagnosis were significant at the .01 point. This was true in the Arithmetic, Similarities, and Digit Span models, but no significance was found in the Pre IQ models (Tables 15, 16, and 17). Perhaps this was due to an increase in the total n (360 scores for total Verbal Scale as compared with 180 for either of the three subtest combinations). As the total n increases, the accuracy of the F test also increases, and less differences are needed to reach significant points (Lindquist, 1956, p. 41).

The Tukey (a) procedure as described by Winer (1962, pp. 85-89) was used to study these differences. It was found that the NI group scored significantly higher (.01) than did either clinical group. No significant differences were found between the BD and CS groups. The results are shown in Table 18.

The main effects for the verbal subtests were significant at the .01 point. As noted in the

Pre IQ and Arithmetic, Similarities, and Digit Span combinations studied separately, no significant differences resulted. Thus, the significance of this main effect appeared to involve the differences between these two combinations (Tables 15, 16 and 17). The Tukey (a) procedure as described by Winer (1962, pp. 85-89) was used to study these findings (Table 19). Two clusters of subtests did emerge as expected with the Pre IQ tests being one and the Arithmetic, Similarities and Digit Span the other. However, there was also a .05 significant difference between the Vocabulary and Information subtests. It should be pointed out that Information, Comprehension and Vocabulary subtests showed higher scores than did Arithmetic, Similarities and Digit Span. These findings can be interpreted more meaningfully when the interactions are presented and will be withheld at this time.

Interactions

All interactions with the subject variables were significant at either the .01 or .05 point. As pointed out previously, such results are of little interpretive value since subject triads were not equated in terms of age, sex, and Pre IQ.

The interactions between sex and diagnosis, and sex and subtests showed no significant differences, nor did the interactions between age and diagnosis and age and subtests. Thus, when these two variables were controlled, it was noted that interaction effects were not present to a significant degree.

The diagnosis - subtest interactions were found significant for all three models. Since the diagnosis - subtests totals considered were the same for all three models, only one interpretation needs to be made. As noted, the rank order for all three groups remains basically the same with only very minor deviations. The interaction effects, then, appear to be due primarily to the extent of the differences between the two clinical groups and the NI control group (Lindquist, 1956, p. 229). As noted, these differences appear specific to the Arithmetic, Similarities, and Digit Span subtests. In order to quantify such differences, variance components of diagnosis - subtest interactions were computed (Lindquist, 1956, p. 373). These are shown in Table 20. The NI group showed negative deviations from the grand mean on the Pre IQ subtest and positive deviation on the Arithmetic, Similarities, and Digit Span subtests, while the two clinical groups tended quite strongly toward the opposite.

The relevant findings to the purpose of this study were: (1) That a significant difference between the NI control group and the two clinical groups on the Verbal subtests occurred; and (2) more specifically, this difference related to a much poorer performance by both clinical groups on the Arithmetic, Similarities, and Digit Span subtests of the Verbal Scale.

The lack of significance of differences between the diagnostic groups on the Information, Comprehension, and Vocabulary subtests may not be genuine, however, since these subtests were used as a matching criterion. However, it has been reported that these subtests do tend to hold up in the presence of severe clinical disorders (Morrow and Marx, 1955; Wechsler, 1958, p. 171) with minor variations between these subtests. Such a minor variation was in fact noted in the study, with Information being slightly (.05) lower than Vocabulary.

In the presence of a CS reaction or a chronic brain disorder without-psychosis, the Arithmetic, Similarities, and Digit Span scores should tend to drop significantly below premorbid levels of intellectual ability. No significant differences between the two clinical groups were noted, thus no inferences can be suggested relative to expected patterns of a particular diagnostic category on the basis of this study.

WAIS Performance

The WAIS performance subtests were subjected to the same three analyses of variance models as were the Pre IQ, WAIS Arithmetic, Similarities, and Digit Span, WAIS Verbal, and PM.

The five factors included in the three analyses of variance models were also the same; namely, (1) Subjects, (2) Age, (3) Sex, (4) Diagnosis, and (5) Subtests, in this case those of the WAIS Performance Scale.

The diagnostic and subtest factors were consistent for each of the three models, using the same column totals. Thus, each of the three models used concerned itself with the subject variable, the age variable, or the sex variable. Results of each model are summarized in Tables 21, 22, and 23.

The main effects of the five factors were found to be as follows: (1) Subjects - Referring to Table 21, it was noted that the subject variable was significant at the .01 point. This, however, is not too meaningful since no attempt was made to equate the twenty triads of subjects.

(2) Age - Main effects of age were found to be significant at the .01 point (Table 22). The younger subjects scored higher than did the older. This is not the same as the Pre IQ in which older subjects scored higher than younger. Since the scores studied in both cases were uncorrected for age, the meaningfulness of such a finding is questionable. Wechsler (1958, p. 142) has noted that as age increases, scale scores on the Performance subtests drop quickly due to both loss of psychomotor speed and the

difficulty involved in certain abstract abilities--notably in the case of Block Design. Thus, such a finding tends to corroborate previous expectations as to the effect of age on the WAIS Performance Scale.

(3) Sex - Referring to Table 23, it was noted that the main effects due to sex were not significant. This is in conflict with the Pre IQ findings which showed for this sample of subjects that men scored higher than women. Since interaction effects were present in all combinations with the sex factor, a discussion of the meaning will be withheld at this point.

(4) Diagnosis - The main effects of diagnosis were found to be significant at the .01 point. This, of course, was true for all three models since the category totals were the same for each model. This is seen in Tables 21, 22, and 23. In an effort to study the meaning of this significance, the Tukey (a) procedure as described by Winer (1962, p. 87) was used. The findings are shown in Table 24, and can be interpreted that the NI group scored significantly higher (.01) than did both clinical groups, and that the CS group scored significantly higher (.01) than did the BD group.

(5) Performance Subtests - The main effects due to the Performance subtests were significant at the .05

point. This finding is common to all three models, since the totals used are the same. This is seen by noting Tables 21, 22, and 23. In order to determine to which subtests the differences appeared to relate, the Tukey (a) procedure as described by Winer (1962, p. 87) was used. Table 25 summarizes the findings. It was noted that the differences appeared to relate primarily to high scores on the Object Assembly and Block Design subtests in comparison with low scores on the Digit Symbol subtest. The remainder of the comparisons were not significant.

Referring to Table 21, it was noted that the subject - diagnosis interaction was significant at the .01 level. This appears to refer primarily to differences between subject triads on different diagnostic levels. Since no attempt was made to equate the subject triads with each other, this finding is not too meaningful.

The sex - diagnostic interactions were found significant at the .05 point as noted in Table 23. In order to attempt to describe this interaction, variance components of the AB interaction of Table 26 were computed using the technique illustrated by Lindquist (1956, p. 372). Orthogonal components are reported in Table 26. It might here be noted that in order to achieve orthogonal relationships, the cell totals were weighted since the cell frequencies were unequal. As noted, the significant interaction appeared to relate primarily to the lower scores of BD females when compared with the grand mean. This perhaps may also explain the lack of significance of the main effects of the sex factor.

The sex - subtest interaction was also found to be significant at the .05 point. Again, the variance components of this interaction were computed following the procedure outlined by Lindquist (1956, p. 372). The AB interaction components of variance are summarized in Table 27. As noted, the significance of the interaction effects appears to relate primarily to low scores of males on Digit Symbol and Block Design subtests; or the reverse, high scores by females on these two subtests. Again, due to unequal cell frequencies, the mean of the cell means was used in order to facilitate orthogonal relationships.

The sex - diagnosis - subtest interaction was found to be significant at the .01 point.

In terms of sex - subtest interaction, it was noted that men scored lower than women on Digit Symbol and Block Design and higher than women on Picture Completion and Picture Arrangement.

The ABC interaction as described by the variance components shown in Table 28 suggest that the major differences occur on the Digit Symbol and Block Design subtests, with NI men scoring much higher than CS men on Digit Symbol, and with BD males scoring much lower than NI and CS males on the Block Design subtest. While other differences were noted, these appeared of less importance.

Zero Order Product Moment Coefficients of Correlation (r)

Zero order product moment coefficients of correlation (r) were computed within each diagnostic sample for two types of data. These were separated due to the use of Pre IQ as background data, and the contamination effects which could thus be present on WAIS Verbal and Full Scale sum of scaled scores with a mixture of background and foreground data. Part-whole correlations (McNemar, 1949, p. 139) were also included in the WAIS Verbal and Full Scale sum of scaled scores with Pre IQ.

Thus, the two types of data are those without a mixture of background and foreground and without part-whole correlations, and those in which the mixture of background and foreground and part-whole correlations are present.

The first correlations were for data without a mixture of background and foreground and without part-whole correlations between age, sex, sum of WAIS Arithmetic, Similarities, and Digit Span scaled scores, WAIS Performance Scale sum of scaled scores, and PM raw score totals. The second correlations were for data with a mixture of background and foreground data and with part-whole correlations are between age, sex, Pre IQ sum of scaled scores, WAIS Verbal Scale sum of scaled scores, and PM total.

These data were separated primarily due to the expectation of positive correlations by using Pre IQ as a part of the total scores with which it was correlated (McNemar, 1949, p. 137).

The r's are presented in Table 29, those correlations in which background-foreground and part-whole relationships are not involved, and in Table 30, those correlations in which background-foreground and part-whole relationships are involved.

After the r's were determined, significance levels were determined from Edwards (1950, p. 408).

Next, comparisons between each similar r (i.e., age - sex) of the three diagnostic samples were obtained using the z' transformation described by Edwards (1950, pp. 131-132). The .05 level of confidence was assumed as the level of significance necessary for assuming differences between z' transformations.

The z' transformations are presented in Table 31 for data in which background-foreground and part-whole correlations were not involved, and in Table 32 for data in which background-foreground and part-whole relationships were present.

The subject variables of age and sex showed no significant r's within the NI and CS groups. The BD group, however, showed a significant (.05 level) positive correlation between the age - WAIS Verbal Scale relationship, and a significant (.05 level) negative correlation between the age - PM total relationship. The correlation between sex and PM totals revealed a significant (.05 level) r, suggesting that BD males scored significantly lower than BD females on the PM. The z' transformations showed the BD group scoring significantly higher (.05 level) on the sex - PM total relationship, inferring that BD males scored significantly lower than did NI and CS males on the PM. The scores with part-whole relationships showed significant positive correlations (Table 30) at the .01 level without significant z' difference (Table 32) for all three diagnostic groups between Pre IQ, WAIS Verbal Scale sum of scaled scores, and WAIS Full Scale sum of scaled scores r with PM totals and Pre IQ not significant for all three groups. The z' comparison did show the r of the BD sample being significantly lower than those of the NI sample. PM raw score totals and Full Scale sum of scaled scores achieved positive significance at the .01 level for the NI and CS samples, but not for the BD sample. The z' transformation showed the BD sample achieving a significantly lower r than did the NI and CS samples.

The r's without part-whole relationships showed the BD group with a significant (.01 level) negative r between WAIS Arithmetic, Similarities, and Digit Span sum of scaled scores and PM raw score totals (Table 29), and the BD group scoring significantly lower r on this correlation than the NI and CS groups in terms of z' transformations (Table 31). The r between PM raw score totals and WAIS Performance Scale sum of scaled scores achieved positive significance at the .01 level (Table 29).

The major finding of merit from the correlation studies was the high positive correlation between PM and WAIS Performance Scale scores for all three diagnostic groups. Also interesting was the significant positive relationship between PM raw score total and WAIS Full Scale sum of scaled scores for the NI and CS samples, with significantly lower r for the BD group as suggested by z' transformations.

Discussion

The Results Section dealt with the statistical techniques applied to the results and a short statement of the significance of these results.

The Discussion Section will attempt to present the major findings from the Results Section, compare these with each other, and then attempt to compare these results with the relevant literature.

As was noted, the results seem to concern themselves with two major areas--the first that of subject factors which may or may not be specific to this paper, and the second, general trends of the test data which should be applicable to testing the major hypotheses of the paper.

Subject Triads. The subject triads showed much variability, both in terms of main effects and interactions. Since the triads were not equated with one another, i.e., since variables of age, sex, and Pre IQ were controlled within but not between the triads (see Table 1), these findings were not meaningful other than to assume that different triads of matched subjects would score in different ways on the various test combinations subjected to statistical analyses.

The subject factor of age showed certain significant findings for all of the test variables. These were not, however, consistent for each test combination.

The main effects of age were significant for all test combinations studied. Younger subjects scored lower than older subjects on WAIS Pre IQ and total Verbal subtests, higher on WAIS Performance and PM raw score totals. This finding of a difference due to the effects of age may not be unusual, since WAIS scaled scores used in the study were uncorrected for age. With verbal measures being more resistant to age changes (Wechsler, 1958, p. 139), it might be assumed that the difference between the directions of relationship between age and test scores is a result of expected pattern. In effect, while WAIS Pre IQ is particularly stable for age, and WAIS Verbal Scale is generally more stable than WAIS Performance Scale for age, the lower scores of older subjects on WAIS Performance is actually an expected pattern. (The possible contamination of using Pre IQ subtests as both background and foreground material might also be in action here.) The same effects of age could, of course, hold true for PM totals, since the mean raw score total drops quite quickly as age advances (Ravens, 1956). In effect, it might be assumed that WAIS Pre IQ and Verbal scores held up with age while WAIS Performance and PM totals did not. These are consistent with findings in the literature (Wechsler, 1958, p. 139; Ravens, 1956).

The factor of sex showed certain differences on overall main effects as well as differences in interaction effects with diagnosis when the results of the analyses of variance were considered. The overall main effects of sex showed men scoring higher than women on Pre IQ and WAIS Verbal, and no significant differences on WAIS sum of Arithmetic, Similarities and Digit Span, WAIS Performance Scale, and PM total raw scores. The lack of significant main effects on WAIS Performance Scales and PM total analyses of variance may have been influenced somewhat by significant interaction effects between sex and diagnostic classification. This interaction appeared significant due to extremely low scores of BD males on Performance and PM tests when compared with the NI and CS males on these tests. These trends were also noted on the correlation studies.

While Wechsler (1958, p. 144) points out sex differences on the WAIS, with men scoring higher on Full Scale scores and on Performance Scale scores, these significances were not noted in the correlation studies.

Basically, the findings associated with the sex factor appear to be questionable due to the low number of subjects involved of each sex (12 men and 8 women in each diagnostic group), and without any attempt to equate the Pre IQ of the sexes. Thus, any overall effects due to sex differences could well be an artifact of this study.

It was noted that in terms of correlation coefficients, Pre IQ showed a consistently significant r for Full Scale and Verbal Scales, and no significant correlation with WAIS Performance Scale. The BD group showed a significant negative correlation between Pre IQ and PM totals, with no significant correlations found for the NI and CS groups.

The positive relationship between Pre IQ and Verbal scaled scores is expected, since the Pre IQ subtests do make up half of the Verbal Scale. Part-whole correlations tend to a positive r (McNemar, 1949, p. 139). All Pre IQ subtests have high loadings on verbal comprehension and on the g factor (Cohen, 1956).

The high loading on the g factor of these three subtests may also relate to the positive r between Pre IQ and WAIS Full Scale (Cohen, 1956). Also these three subtests were used in the computation of the Full Scale WAIS, and the effect of part-whole correlations may be present.

The discussions of the subject factors involved in this study have described the findings associated with each and have attempted to show how these relate to the test scores subjected to statistical analysis. Although certain of the effects of these variables were significant, the use of matching procedures should have prevented any random effects on the tests of the major hypotheses.

Decisions regarding the four hypotheses considered in this paper are discussed next.

Hypothesis (1)--that of no difference between total PM scores of matched subjects drawn from chronic brain disorder without-psychosis, chronic schizophrenic, and non-institutional samples--must be rejected. The BD and CS groups both scored significantly below the NI group (.01 respectively) in total PM scores. These findings were shown from the analysis of variance for PM raw score totals and were presented in Tables 5, 6, and 7. Such findings are consistent with Ravens' statement that emotional or organic deficit will have deleterious effects on PM scores (Ravens, 1956), and that of Urmer, Ann Morris, and Wendland (1960) who found that PM totals for BD subjects were significantly lower than PM totals for NI subjects. Evans and Marmostan (1964) using the coloured PM, found that total raw scores on this instrument were useful in detecting presence or absence of irreversible brain damage. Whether results gained from the coloured PM are directly comparable to the PM (1938) is questionable, but the tendency seems clear.

Hypothesis (2)--that no statistically significant differences between the NI group, the chronic brain disorder group without-psychosis, and the chronic schizophrenic group would be obtained in terms of discrepancy scores--was likewise shown to be at least partially untenable by the use of the Chi Square technique. It was found that the BD group showed significantly more discrepancies than the NI group. No significant differences were shown between the discrepancy scores of the NI and CS groups, and no significant differences were shown between the discrepancy scores of the CS and BD groups. The significant difference between NI and BD subjects parallels Urmer, Ann Morris, and Wendland's findings (1960). Their findings also showed that the BD group made more minus deviations on Set A and more plus deviations (Ravens' discrepancy scores) on Sets D and E of the PM.

Kasper (1958), in his study dealing with emotionally disturbed individuals, did not find meaningful relationships between morbidity scores and disparities among PM sets of scores (which Kasper described as deviation scores). In effect, his results parallel those of this study, with the CS subjects not showing a significant difference in terms of discrepancy scores when compared with the NI group.

These two articles suggest that the results of this study are not unusual in that BD subjects have been found to show more discrepancies than have NI subjects (Urmer, Ann Morris and Wendland, 1960); and that severe emotionally disturbed (in this study, chronic schizophrenics) have not been shown to score significantly more discrepancies (Kasper, 1958).

The third hypothesis--that of no statistically significant differences between the NI group, the CS group, and the chronic brain disorder without-psychosis group in terms of raw score differences on individual Sets A, B, C, D, and E of the PM--was also held untenable. The main effects of diagnosis on total PM scores were significant at the .01 point, and the Tukey (a) test showed the NI group significantly higher than both clinical groups. The interaction effects between diagnosis and PM sets were not significant. This suggests parallel trends for the effects of diagnosis on PM sets for all three samples and would suggest that the NI group scored significantly higher than did the BD and CS groups on each set of the PM. No statistically significant differences between BD and CS groups on any set of the PM could be held tenable. The conclusion was drawn that effects of BD or CS showed consistent interference on all PM sets rather than variable effects.

This is somewhat different than the findings which Urmer, Ann Morris and Wendland (1960) arrived at in that the interaction effects between subject classification (control or brain damage) and PM sets was highly significant (.01 point). They were, however, unable to find consistent interaction trends.

No information relative to set scores other than discrepancies (deviations) was reported by Kasper (1958), thus no information relative to PM set-score differences between NI and severely emotionally disturbed subjects is available.

Ravens (1956) did not specifically suggest any possible relationships between pathology of either organic or emotional nature and PM sets. Thus, it was assumed that Ravens considered it likely that the lowered total PM would be distributed evenly in line with the normal score composition for a particular total PM score. The findings of this study would tend to support such an assumption.

The fourth hypothesis--that of no statistically significant differences between the coefficients of correlation (r) of the chronic brain disorder without-psychosis sample, chronic schizophrenic sample, and noninstitutional sample relative to their performance on the PM as compared with the WAIS Performance Scale sum of scaled scores, and with the sum of the WAIS Arithmetic, Similarities, and Digit Span scaled scores--was held tenable for the NI and CS samples in terms of the WAIS Arithmetic, Similarities, and Digit Span correlations with PM, and for all three samples in terms of the WAIS Performance r with PM.

To clarify this further, the NI and CS samples did not show a significant correlation between PM and WAIS Arithmetic, Similarities, and Digit Span scores. The BD sample, however, showed a significant negative correlation (.05 level) between these scores.

The correlations between PM and WAIS Performance Scale sum of scaled scores were significant at the .01 level in a positive direction.

In terms of other correlations incidental to the purpose of the study, it was found that correlations between WAIS Full Scale and Verbal Scale sum of scaled scores were all positive and all significant at the .01 level for the NI and CS groups, but not for the BD group. Thus, for this study, it would be predicted that BD subjects would not show high correlations between PM total and WAIS Full Scale and Verbal Scale sum of scores. This could possibly reflect contamination from the use of Pre IQ subtests (which make up parts of both Full Scale and Verbal Scale).

The high correlations between WAIS Performance and PM totals are consistent for all three groups, and would appear to be of predictive value.

Correlations between WAIS Full Scale and Verbal Scale sum of scores were all positive and all significant at the .01 level for the NI and CS groups, but not for the BD group. Thus, BD subjects cannot be expected to show high correlations between PM totals and WAIS Full Scale or Verbal Scales, but can be expected to show high correlations between WAIS Performance and PM totals.

Such findings for the BD sample parallel that of Urmer, Ann Morris, and Wendland (1960). Their findings showed correlation for control subjects of .47, .43, and .45 for WAIS Full Scale, Verbal Scale and Performance Scale respectively; and .40, .03, and .73 for WAIS Full Scale, Verbal Scale and Performance Scale for the BD group.

Their conclusion was that the high correlation between WAIS Performance was due to performance aspects of the WAIS being more sensitive to brain damage than the verbal part.

The findings in this study suggest that the total PM raw scores are definitely affected by emotional and organic pathology. These findings tend to show little difference in total PM raw scores due to the nature of the pathology (whether emotional or organic) but do tend to show schizophrenic subjects holding a more consistent relationship with WAIS scales than did the BD subjects. Again, this may relate to the wide range of subjects included in the chronic brain disorder without-psychosis group, with much more variability due to differing degrees and types of organic damage.

The findings associated with the low scores of the BD group on the PM and the lack of correlation of this group with Verbal and Full Scale scores would tend to suggest that, if the PM actually is a measure of Spearman's g as Ravens proposes, brain damage shows an inconsistent but definitely disruptive influence on the g factor.

In addition to this, the definite inability to deal with abstract non-verbal material is quite dramatically shown for the BD group. This finding is also true for the CS group, but the variability within the CS group appears to be much more consistent in relation to other intellectual factors (such as verbal intelligence as measured by WAIS Verbal, and general intelligence as measured by WAIS Full Scale).

Thus, the effects of severe emotional disruption on the PM seem to suggest parallel disruption on both g and verbal comprehension factors, while the BD findings suggest that the disruption may be more consistent for performance abilities, visual motor abilities, and perceptual organizational abilities than for verbal comprehension, memory, and g.

While this would indicate that BD subjects have a strong tendency toward maintaining verbal abilities in the face of severe organic disability, other authors (Shawling, 1957; Milgram, 1959) have suggested that the relative resistance of verbal factors to interference from brain damage may actually reflect a fallacy in the tests. The impression given is that although brain damage subjects may actually respond correctly in terms of the various test requirements, their understanding of and ability to use verbal concepts is in actuality not present to the level reflected on the test scores.

Ravens (1956) suggests that the effects of organic dysfunction are first shown in the abstract areas--the areas requiring reasoning by analogy.

Both schizophrenic subjects and brain damaged subjects are notably considered to lack these abilities to a progressive degree as the level of disruption increases.

Thus, the observed results in this study would be consistent with these expectations in terms of total PM raw scores. Some comment relative to the PM set totals might, however, add a cautious element to these clear and simple results. Ravens (1956) states that this type of reasoning ability develops at approximately age 11 and is shown by subjects 'beginning' to respond correctly to the later items in Series C, D, and to some extent E. This, then, would imply that an adult BD or CS subject should score quite well on Sets A and B which do not require abstract reasoning. This was not the case in this study, which showed consistently lower scores for BD and CS subjects compared with a normal control group, nor was it the case for Urmer, Ann Morris and Wendland's study (1960) which showed the brain damaged had significant numbers of minus deviations on Set A (not expected to require abstract reasoning) and plus deviations on Sets D and E (expected to require abstract reasoning ability).

These tendencies could imply that the effects of either brain damage or chronic schizophrenia actually show overall disruption in intellectual ability. As postulated earlier, this would again relate to the hypothesis that the relatively intact verbal abilities of brain damaged subjects might in effect be due to test fallacies.

Implications for Future Research and Use of PM in Clinical

Settings

The results of this study have indicated that the PM shows definite disruption in the light of chronic organic or emotional pathology. Certain inconsistent findings relative to subject factors were noted--one being that older BD subjects scored significantly lower than did matched subjects in the NI and CS groups. Such a finding could suggest two possibilities--that the older BD subjects had a more serious degree of organic involvement, or that age plays a more disruptive role on intellectual abilities of the type measured by the PM. Perhaps such a question could be subjected to further examination.

Another finding was that BD males scored significantly lower than did BD females. While the author feels these findings are most likely invalid due to small sample sizes, a further study of sex differences on the PM might prove fruitful, both for BD subjects and for other subjects. No data has been presented which has investigated the question of sex differences on PM, although one might conclude that such differences may be negligible due to Ravens lack of mention of such a possibility.

A further question of the lack of relationship between WAIS Full Scale and Verbal measures with BD subjects could be raised, although the trend seems clear that BD subjects do not show significant correlations on this measure. Perhaps further study would add more credence to these findings. One implication is clear from the findings of this study and that of Urmer, Ann Morris and Wendland (1960), and is that PM scores cannot be expected to give an adequate estimate of intellectual ability for a brain damaged individual. At the same time, the implication is present that the PM record which has a significant discrepancy score should not be interpreted, and that further investigation of the subject should be carried through. This, of course, parallels Ravens' suggestion (1956).

For schizophrenic subjects, however, the results of this study would suggest that the PM could give a valid impression of a person's overall intellectual ability at the time of testing. Such a use, however, might be somewhat unimformative due to the lack of significant clinical material which can be gained from the use of the PM as opposed to other intelligence tests, notably the WAIS. As a screening indicator, or in cases where physical handicaps or cultural problems are present, the PM could be a valuable instrument.

Ravens' (1956) suggestion that the PM be used in conjunction with the Mill Hill Vocabulary Scale seems well taken. However, it might be more meaningful to develop adequate norms for PM scores in conjunction with a more widely used vocabulary scale for American usage. Perhaps norms between WAIS Vocabulary subtest or WAIS Verbal Scale and the PM could be developed which would lead to more validity for intellectual estimates.

Summary and Conclusions

A total of sixty subjects, twenty each of chronic brain disorder without-psychosis, chronic schizophrenic, and noninstitutional populations were individually matched within one standard deviation on premorbid intelligence levels (a sum of WAIS Information, Comprehension, and Vocabulary), within five year age intervals, and sex. These subjects were then administered the remainder of the WAIS and the PM in an ab-ba order (so that ten subject triads were administered the PM first, the other ten subject triads were administered the remainder of the WAIS first).

The BD and CS samples scored significantly lower on the PM, the sum of scaled scores of WAIS Arithmetic, Similarities, and Digit Span subtests, and WAIS Performance subtest than did the NI sample.

The BD subjects scored significantly more discrepancy scores on PM sets (Ravens, 1956) than did NI subjects. No significant differences were noted between NI and CS subjects, nor between CS and BD subjects.

Pearson Product Moment coefficient of correlation showed significant positive correlation between PM totals and WAIS Performance for all three diagnostic samples, and a significant positive correlation between PM totals and WAIS Full Scale for the NI and CS groups, but not for the BD group. The Full Scale scores, however, might have been contaminated by the use of Pre IQ for matching purposes. The BD subjects also scored a significant negative correlation between PM totals and WAIS Arithmetic, Similarities, and Digit Span subtests. Generally, correlations for the NI and CS samples were not significantly different as measured by z' transformation, but the BD sample showed significantly lower z' scores than did NI subjects in terms of Pre IQ - PM, and significantly lower z' scores than did both the NI and CS groups in terms of Full Scale - PM, Verbal - PM, and Arithmetic, Similarities, and Digit Span - PM correlations.

These findings were discussed in terms of previous articles on the PM (1938 Form), and conclusions were that the results paralleled previous findings. Low correlation between Pre IQ, Full Scale and Verbal Scale for the BD group was discussed in terms of the retention of high verbal scores for BD subjects possibly being an artifact of the scoring criteria for verbal scales.

Conclusions were that effects of severe emotional and organic pathology were consistent for all sets of PM, lowering the scores to the same degree.

Implications were that the PM appeared to be an estimate of g; i.e., overall intellectual ability, for NI and CS subjects; and can be profitably used as a screening instrument for such subjects. It was felt that such use for suspected cases of brain damage would be highly unwise, and that PM subjects showing significant discrepancies should be studied further.

Implications for further research were that studying sex differences on PM raw scores might be informative, and that the combination of age and organic pathology might interfere with PM totals more significantly than would be the case for either factor taken separately.

Another suggestion was that Ravens' recommendation that the Mill Hill Vocabulary Scale be used in conjunction with the PM could offer a check upon the validity of the PM. An alternative suggestion was made that norms for WAIS Vocabulary subtest and/or Verbal Scale be developed in conjunction with the PM.

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Table 1

Matching Criteria

Chronic Brain Disorder				Chronic Schizophrenic Reaction				Non-institutional			
Code	Sex	Age	Pre IQ	Code	Sex	Age	Pre IQ	Code	Sex	Age	Pre IQ
1	M	26	91	31	M	28	89	71	M	26	87
2	M	23	101	32	M	23	109	72	M	21	108
3	M	38	119	33	M	37	119	73	M	39	102
4	F	41	90	34	F	40	90	74	F	44	98
5	M	23	93	35	M	23	95	75	M	24	95
6	M	52	106	36	M	51	110	76	M	52	102
7	F	28	95	37	F	29	91	77	F	28	107
8	M	54	120	38	M	50	122	78	M	51	124
9	F	54	106	39	F	53	112	79	F	50	101
10	F	29	85	40	F	26	91	80	F	26	87
11	M	53	133	41	M	54	122	81	M	51	133
12	M	25	91	42	M	29	89	82	M	25	89
13	F	49	98	43	F	46	98	83	F	47	104
14	M	28	99	44	M	29	105	84	M	28	105
15	M	29	95	45	M	30	102	85	M	28	97
16	M	24	91	46	M	21	91	86	M	24	99
17	F	52	98	47	F	52	102	87	F	54	110
18	M	25	105	48	M	26	107	88	M	27	91
19	F	22	89	49	F	24	99	89	F	23	99
20	F	28	91	50	F	29	89	90	F	29	99

Table 2

Summary Analysis of Variance

(A = Subject triads; B = Diagnosis; C = Pre IQ Subtests--WAIS Information, Comprehension and Vocabulary.)

Source	df	MS	F
A	19	26.64	17.96**
B	2	1.07	1.00
C	2	10.77	7.26**
AB	38	2.53	1.70*
AC	38	3.63	2.45**
BC	4	1.67	1.13
ABC[a]	76	1.48	

[a]With one subject per cell, the error within cell was assumed to be zero. ABC was used as the error term and as the divisor in the F ratios.

*Significant at .05 point.

**Significant at .01 point.

Table 3

Summary Analysis of Variance

(A = Age; B = Diagnosis; C = Pre IQ Subtests--

WAIS Information, Comprehension and Vocabulary.)

Source	df	MS	F
A	1	95.34	21.16**
B	2	1.07	1.00
C	2	10.77	2.39
AB	2	0.27	1.00
AC	2	2.37	1.00
BC	4	1.67	1.00
ABC	4	5.36	1.19
Error	162	4.51	

**Significant at .01 point.

Table 4

Summary Analysis of Variance

(A = Sex[a]; B = Diagnosis; C = Pre IQ Subtests--

WAIS Information, Comprehension and Vocabulary.)

Source	df	MS	F
A	1	49.01	10.17**
B	2	2.61	1.00
C	2	11.80	2.45
AB	2	7.52	1.56
AC	2	1.45	1.00
BC	4	1.79	1.00
ABC	4	1.57	1.00
Error	162	4.82	

[a]Unweighted means.

**Significant at .01 point.

Table 5

Summary Analysis of Variance

(A = Subject Triads; B = Diagnosis;

C = Progressive Matrices Sets A, B, C, D, and E.)

Source	df	MS	F
A	19	17.34	5.52**
B	2	290.20	92.39**
C	4	443.10	141.67**
AB	38	25.90	8.20**
AC	76	2.93	1.00
BC	8	5.51	1.75
ABC[a]	152	3.14	

[a]With one subject per cell, the error within cell was assumed to be zero. ABC was used as the error term and as the divisor in the F ratios.

**Significant at the .01 point.

Table 6

Summary Analysis of Variance

(A = Age; B = Diagnosis; C = Progressive Matrices Sets A, B, C, D, and E.)

Source	df	MS	F
A	1	72.03	10.97**
B	2	29.20	4.45**
C	4	443.10	67.47**
AB	2	57.33	8.73**
AC	4	3.55	1.00
BC	8	5.51	1.00
ABC	8	4.96	1.00
Error	270	6.57	

**Significant at .01 point.

Table 7

Summary Analysis of Variance

(A = Sex[a]; B = Diagnosis; C = Progressive

Matrices Sets A, B, C, D, and E.)

Source	df	MS	F
A	1	2.00	1.00
B	2	246.25	36.70**
C	4	432.78	64.52**
AB	2	83.74	12.48**
AC	4	1.81	1.00
BC	8	5.05	1.00
ABC	8	2.96	1.00
Error	270	2706.71	

[a]Unweighted means.

**Significant at .01 point.

Table 8

Summary of Tukey (a) Procedure

(B_1 = Noninstitutional, B_2 = Chronic schizophrenic, and B_3 = Chronic brain disorder without-psychosis.)

	B_2	B_1
B_3	.33	11.87**
B_2		11.08**

**Significant at .01 point.

Table 9

Variance Components for Sex - Diagnosis

Interaction on PM

(B_1 = Noninstitutional, B_2 = Chronic schizophrenic,

B_3 = Chronic brain disorder without-psychosis,

A_1 = Men, and A_2 = Women.)

	B_1	B_2	B_3
A_1	+1.16	+1.33	-2.49
A_2	-1.16	-1.33	+2.49

Table 10

Variance Components for Age - Diagnosis

Interaction on FM

(B_1 = Noninstitutional, B_2 = Chronic schizophrenic,

B_3 = Chronic brain disorder without-psychosis,

A_1 = Younger, and A_2 = Older.)

	B_1	B_2	B_3
A_1	-.63	-.21	+.84
A_2	+.63	+.21	-.84

Table 11

Summary Analysis of Variance

(A = Subject triads; B = Diagnosis; C = WAIS Verbal Subtests Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	19	16.97	4.17**
B	2	96.80	23.84**
C	2	10.65	2.62
AB	38	5.01	1.23
AC	38	4.84	1.19
BC	4	6.63	1.63
ABC[a]	76	4.06	

[a]With one subject per cell, the error within cell was assumed to be zero. ABC was used as the error term and as the divisor in the F ratios.

**Significant at .01 point.

Table 12

Summary Analysis of Variance

(A = Age; B = Diagnosis; C = WAIS Verbal

Subtests Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	1	36.45	6.27*
B	2	96.82	16.66**
C	2	10.07	1.73
AB	2	1.02	1.00
AC	2	11.27	1.94
BC	4	6.38	1.10
ABC	4	0.68	1.00
Error	162	5.81	

*Significant at .05 point.

**Significant at .01 point.

Table 13

Summary Analysis of Variance

(A = Sex[a]; B = Diagnosis; C = WAIS Verbal

Subtests Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	1	0.81	1.00
B	2	106.98	17.74**
C	2	3.68	1.00
AB	2	3.13	1.00
AC	2	1.50	1.00
BC	4	10.37	1.72
ABC	4	8.88	1.47
Error	162	6.03	

[a]Unweighted means.

**Significant at .01 point.

Table 14

Summary of Tukey (a) Procedure

(B_1 = Noninstitutional, B_2 = Chronic schizophrenic, and B_3 = Chronic brain disorder without-psychosis.)

	B_2	B_1
B_3	.76	7.60**
B_2		6.37**

**Significant at .01 point.

Table 15

Summary Analysis of Variance

(A = Subject Triads; B = Diagnosis; C = WAIS Verbal Subtests Information, Comprehension, Vocabulary, Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	19	35.42	12.44**
B	2	58.68	20.61**
C	5	40.87	14.36**
AB	38	4.36	1.53*
AC	95	5.03	1.77**
BC	10	11.06	3.89**
ABC[a]	190	2.85	

[a]With one subject per cell, the error within cell was assumed to be zero. ABC was used as the error term and as the divisor in the F ratios.

*Significant at .05 point.

**Significant at .01 point.

Table 16

Summary Analysis of Variance

(A = Age; B = Diagnosis; C = WAIS Verbal

Subtests Information, Comprehension, Vocabulary,

Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	1	124.84	24.20**
B	2	58.68	11.38**
C	5	40.87	7.92**
AB	2	1.08	1.00
AC	5	6.85	1.33
BC	10	11.07	2.15*
ABC	10	2.46	1.00
Error	324	5.16	

*Significant at .05 point.

**Significant at .01 point.

Table 17

Summary Analysis of Variance

(A = Sex[a]; B = Diagnosis; C = WAIS Verbal

Subtests Information, Comprehension, Vocabulary,

Arithmetic, Similarities, and Digit Span.)

Source	df	MS	F
A	1	25.11	4.61*
B	2	67.07	12.36**
C	5	32.20	5.94**
AB	2	10.63	1.96
AC	5	3.74	1.00
BC	10	13.21	2.44**
ABC	10	4.16	1.00
Error	324	5.43	

[a]Unweighted means.

*Significant at .05 point.

**Significant at .01 point.

Table 18

Summary of Tukey (a) Procedure

(B_1 = Noninstitutional, B_2 = Chronic schizophrenic, and B_3 = Chronic brain disorder without-psychosis.)

	B_2	B_1
B_3	2.01	6.35**
B_2		4.25**

**Significant at .01 point.

Table 19

Summary of Tukey (a) Procedure

(A = Arithmetic; DS = Digit Span; S = Similarities;

I = Information; C = Comprehension; and V = Vocabulary.)

	DS	S	I	C	V
A	3.74	4.50	7.98**	11.23**	2.88**
DS		.79	4.24	7.48**	9.17**
S			3.46	6.71**	8.37**
I				3.25	4.90*
C					1.67

*Significant at .05 point.

**Significant at .01 point.

Table 20

Variance Components of Diagnosis - Subtest Interaction (B_1 = Noninstitutional, B_2 = Chronic schizophrenic, B_3 = Chronic brain disorder without-psychosis, I = Information, C = Comprehension, V = Vocabulary, A = Arithmetic, S = Similarities, and DS = Digit Span.)

	I	C	V	A	S	DS
B_1	-.85	-.63	-.50	+1.26	+.49	+.22
B_2	+.07	+.39	+.32	-.43	-.54	+.19
B_3	+.77	+.24	+.17	-.83	+.06	-.41

Note.-Some rounding errors are apparent across rows and down columns.

Table 21

Summary Analysis of Variance

(A = Subject triads; B = Diagnosis; C = WAIS Performance Subtests Digit Symbol, Picture Completion, Block Design, Picture Arrangement, Object Assembly.)

Source	df	MS	F
A	19	20.29	4.60**
B	2	364.58	82.67**
C	4	19.28	4.37**
AB	38	15.30	3.46**
AC	76	5.86	1.32
BC	8	6.35	1.43
ABC[a]	152	4.41	

[a]With one subject per cell, the error within cell was assumed to be zero. ABC was used as the error term and as the divisor in the F ratios.

**Significant at .01 point.

Table 22

Summary Analysis of Variance

(A = Age; B = Diagnosis; C = WAIS Perforance

Subtests Digit Symbol, Picture Completion, Block Design,

Picture Arrangement, Object Assembly.)

Source	df	MS	F
A	1	60.76	8.74**
B	2	364.59	52.46**
C	4	19.28	2.77*
AB	2	2.01	1.00
AC	4	5.33	1.00
BC	8	6.35	1.00
ABC	8	3.67	1.00
Error	270	6.95	

*Significant at .05 point.

**Significant at .01 point.

Table 23

Summary Analysis of Variance

(A = Sex[a]; B = Diagnosis; C = WAIS Performance Subtests Digit Symbol, Picture Completion, Block Design, Picture Arrangement, Object Assembly.)

Source	df	MS	F
A	1	2.89	1.00
B	2	328.74	50.72**
C	4	17.14	2.64*
AB	2	23.08	3.56*
AC	4	17.91	2.76*
BC	8	5.95	1.00
ABC	8	453.27	69.93**
Error	270	6.48	

[a]Unweighted means.

*Significant at .05 point.

**Significant at .01 point.

Table 24

Summary of Tukey (a) Procedure

(B_1 = Noninstitutional; B_2 = Chronic schizophrenic, and B_3 = Chronic brain disorder without-psychosis.)

	B_2	B_1
B_3	6.71**	20.11**
B_2		13.40**

**Significant at .01 point.

Table 25

Summary of Tukey (a) Procedure

(C_1 = Digit Symbol; C_2 = Picture Completion; C_3 = Block Design; C_4 = Picture Arrangement; and C_5 = Object Assembly.)

	C_2	C_4	C_3	C_5
C_1	3.32	3.60	4.32*	6.50**
C_2		.27	1.11	3.19
C_4			.83	2.91
C_3				2.07

*Significant at .05 point.

**Significant at .01 point.

Table 26

Variance Components of Sex - Diagnosis Interaction (B_1 = Noninstitutional, B_2 = Chronic schizophrenic, B_3 = Chronic brain disorder without-psychosis, A_1 = Men, and A_2 = Women.)

	B_1	B_2	B_3
A_1	+.47	+.87	-1.33
A_2	-.47	-.87	+1.33

Note.-Some rounding errors are apparent across rows.

Table 27

Variance Components of Sex - Subtest Interaction (C_1 = Digit Symbol, C_2 = Picture Completion, C_3 = Block Design, C_4 = Picture Arrangement, C_5 = Object Assembly, A_1 = Men, and A_2 = Women.)

	C_1	C_2	C_3	C_4	C_5
A_1	-1.49	+1.28	-1.02	+1.41	-.19
A_2	+1.48	-1.28	+1.02	-1.41	+.19

Note.-Some rounding errors are apparent across rows and down columns.

Table 28

Variance Components of Sex - Diagnosis - Subtest Interaction

(C_1 = Digit Symbol; C_2 = Picture Completion; C_3 = Block Design; C_4 = Picture Arrangement; C_5 = Object Assembly; A_1 = Men; and A_2 = Women.)

Noninstitutional

	C_1	C_2	C_3	C_4	C_5
A_1	+1.07	-.25	+.05	-.43	-.43
A_2	-1.06	+.25	-.05	+.43	+.43

Chronic Schizophrenic

	C_1	C_2	C_3	C_4	C_5
A_1	-1.53	-.10	+.90	+.16	+.57
A_2	+1.54	+.10	-.90	-.17	-.57

Chronic Brain Disorder Without-Psychosis

	C_1	C_2	C_3	C_4	C_5
A_1	+.47	+.35	-.95	+.42	-.28
A_2	-.47	-.35	+.95	-.42	+.28

Note.-Some rounding errors are apparent across rows and down columns.

Table 29

Product-Moment r

(A, S & DS = Arithmetic, Similarities and Digit Span; and P = Performance.)

Chronic Schizophrenic

	Sex	A, S & DS	P	PM
Age	.19	.42	.21	.04
Sex		.05	-.20	-.31
A, S & DS			.22	.27
P				.75**

Noninstitutional

	Sex	A, S & DS	P	PM
Age	.19	.22	-.19	-.08
Sex		.11	-.17	-.35
A, S & DS			.12	.29
P				.59**

Chronic Brain Disorder Without-Psychosis

	Sex	A, S & DS	P	PM
Age	.19	.34	-.31	-.48*
Sex		-.13	.23	.47*
A, S & DS			.08	-.56*
P				.60**

*Significant at .05 level.

**Significant at .01 level.

Table 30

Product-Moment r

(FS = Full Scale, and VS = Verbal Scale.)

Chronic Schizophrenic

	Sex	Pre IQ	FS	VS	PM
Age	.19	.51*	.16	.40	.04
Sex		-.35	-.24	-.18	-.31
Pre IQ			.60**	.81**	-.28
FS				.81**	.71**
VS					.38

Noninstitutional

	Sex	Pre IQ	FS	VS	PM
Age	.19	.48*	.54*	.43	-.08
Sex		-.13	-.10	.01	-.35
Pre IQ			.53*	.58**	.34
FS				.80**	.64**
VS					.40

Chronic Brain Disorder Without-Psychosis

	Sex	Pre IQ	FS	VS	PM
Age	.19	.36	.13	.52*	-.48*
Sex		-.41	-.08	-.36	.47*
Pre IQ			.52*	.83**	-.44
FS				.66**	.14
VS					-.45*

*Significant at .05 level.

**Significant at .01 level.

Table 31

Comparison of z' Transformations of r

(A, S & DS = Arithmetic, Similarities and Digit Span; and P = Performance.)

		Sex	A, S & DS	P	PM
	NI-CS	.15	-.64	-1.20	.35
Age	NI-BD	.15	-.35	-.38	1.30
	BD-CS	.00	-.29	1.56	1.66
	NI-CS			.09	.15
Sex	NI-BD			-1.18	2.55*
	BD-CS			1.27	2.41*
	NI-CS			-.31	.06
A, S & DS	NI-BD			.11	2.49*
	BD-CS			-.41	2.43*
	NI-CS				.87
P	NI-BD				.02
	BD-CS				.85

*Significant at .05 level.

Table 32

Comparison of z' Transformations of r

		Sex	Pre IQ	Full Scale	Verbal	PM
	NI-CS	.46	-.12	1.29	.09	.35
Age	NI-BD	.15	.45	1.40	-.34	1.30
	BD-CS	.00	1.15	.10	.72	1.66
	NI-CS		-.68	.44	-.53	1.98*
Sex	NI-BD		-.91	.07	-1.10	-.42
	BD-CS		.22	.51	-.57	2.41
	NI-CS			-.28	-1.36	.23
Pre IQ	NI-BD			.04	1.53	2.43*
	BD-CS			-.32	.18	.55
	NI-CS				-.08	-.38
Full Scale	NI-BD				.89	3.49*
	BD-CS				-.97	-3.86*
	NI-CS					.09
Verbal	NI-BD					2.65*
	BD-CS					-2.59*
	NI-CS					-.87
Performance	NI-BD					-.02
	BD-CS					-.85

*Significant at .05 level.